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# METHOD OF TEST FOR HIGH PRESSURE SODIUM LAMP MULTIPLE SUPPLY BALLASTS

**CAUTION:** Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read **"SAFETY AND HEALTH"** in Section D of this method. It is the responsibility of whoever uses this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed. Users of this method do so at their own risk.

## A. SCOPE

The object of this test is to determine power factor, regulation and crest factor on high pressure sodium lamp, multiple supply ballasts.

## B. APPARATUS: TYPICAL

1. YEW Yokogawa Digital Power Factor Meter, Model 2524.
2. Magtrol Power Analyzer, Model 4612.
3. Tektronix Oscilloscope Model, 2465.
4. Fluke Digital Multimeter, Models 8050A and 8060A.
5. Hewlett Packard X-Y Recorder, Model 7035B.
6. Two Powerstat Variable Autotransformers, 10 Amp.
7. Reflective Oven with Quartz Halogen Lamp.
8. Assorted H. P. S. lamps from 70 to 400 watts.

## C. TEST PROCEDURE

### a) Stabilized Lamp Operation

1. Connect the primary and secondary leads from the test set-up to the primary and secondary connection points on the ballast under test (See Figure 1). Estimate the approximate current and voltage and set the meter ranges accordingly.
2. Determine input voltage required. If 120 volts is needed, bypass the Westinghouse Transformer (See Figure 4, Power Control Board) by setting S1 and S2 to 120 volts. When 216 volts to 528 volts is needed, the Westinghouse Transformer should be used by setting S1 to primary, S2 to secondary and S3 to 208 volt input. The power cord input should be inserted in 120 volt receptacle for 120 volt testing and in the 208 volt receptacle for voltages above 216.
3. Turn MAIN POWER breaker ON.
4. Turn Magtrol and YEW Yokogawa Meter POWER SWITCHES ON.
5. Determine that meter protection switches are off before turning POWER VARIAC ON. These include the primary side

voltmeter and ammeter and the secondary side voltmeter and ammeter. The meters must be protected because a HPS lamp needs a 2500 volt pulse to start. The testing of starters will not be covered in this Test Method.

6. Turn POWER VARIAC SWITCH ON and adjust the variac to the specified ballast input voltage. METER SWITCHES can be turned ON after the test lamp ignites.

7. Allow lamp to stabilize (approximately 20 minutes) before recording input and output parameters on the HPS Ballast Testing form (See Figure 2). Input current, watts and power factor are measured on the YEW Yokogawa Digital Power Factor Meter, Model 2524. The output voltage, current and watts are measured on the Magtrol Analyzer, Model 4612. The peak current is measured on the Tektronix Oscilloscope Model, 2465 which is calibrated to 1.0 amp (peak) per division.

### b) Dynamic Lamp Operation

1. Determine regulation throughout lamp life by making three separate traces on the Hewlett Packard X-Y Recorder. Curves are made at nominal line voltage and at +/- 10% of line voltage.

   The lamp manufacturers have established a range of limits within which the HPS lamps must be maintained over the lamp life, to achieve published lamp performance (See Figure 5). The volt-watt trace is recorded as the lamp warms up to its stabilization temperature. To duplicate further aging of the lamp (1.2 lamp volt rise per 1000 burning hours) the temperature at the cold spot is increased. The volt-watt trace passes thru the trapezoid until the lamp extinguishes at the end of lamp life. Increasing the spot the lamp in an aluminum reflector oven with a Quartz Halogen lamp. Regulation is calculated by using the following formula (See Figure 6) :

   $$\text{Regulation} = \frac{\text{Point A - Point C}}{\text{Point B}} \times 100\ \%$$

   To determine lamp wattage regulation at any lamp voltage, draw a line parallel to the closest side of the trapezoid and through the point where the lamp voltage line intersects the lamp wattage line. Designate the +10 % rated line volts as A, the rated line voltage as B, and the –10 % rated line volts as C. (See Figure 6). Calculate the percent deviation from design center.

$$\%\ \text{Deviation} = \frac{(\text{W measured - W design})}{\text{W design}} \times 100$$

Ex: $\frac{206 - 200}{200} \times 100 = 3$ percent

2. The Hewlett Packard X-Y Recorder is setup for regulation measurements as follows:

   a) POWER VARIAC in OFF position.

   b) Prepare a trapezoid per ANSI specification. Refer to Figure 4 and sample plots. Use Hewlett-Packard 177.8 mm X 254 mm chart paper No. 9270-1006.

   c) Turn HP 7035B RECORDER ON.

   d) Place graph paper on the recorder.

   e) Turn Recorder HOLD SWITCH ON.

   f) Turn the VOLTS SWITCH ON and the WATTS/POWER FACTOR SWITCH to the WATTS position (located on panel).

   g) Set VOLT/WATT SWITCH to WATT (located on top panel).

   h) Adjust WATT SUPPRESSION POT until Fluke Multimeter 8050A reads zero (located on top panel).

i) Turn Recorder SERVO SWITCH to VOLT.

j) Adjust the Recorder Y-Axis ZERO POT to read zero on the Y-Axis of the recorder.

k) Set VOLT/WATT SWITCH to VOLT.

l) Adjust VOLT SUPPRESSION POT until Fluke 8050A reads zero.

m) Adjust the Recorder X-Axis ZERO POT to read zero on the X-Axis of the recorder.

n) Leave VOLT/WATT SWITCH on VOLT. Calibrate the X-Axis high range by adjusting the VOLT SUPPRESSION POT to read a dc voltage on the Fluke 8050A equivalent to a lamp voltage on the high end (See Figure 7 - Voltage/Wattage Curve Calibration Settings).

o) Adjust X-Axis VERNIER to set the pen on the correct X-Axis voltage. Ex: 120 V = 3.968 VDC, 120 V + 20 V offset = 140 Volt calibration point.

p) Set the VOLT/WATT SWITCH to WATT and calibrate the Y-Axis high end by adjusting the WATT SUPPRESSION POT to read the dc voltage equivalent to the lamp wattage selected for calibration (See Figure 7 for Calibration Settings).

q) Adjust Y-Axis VERNIER to set the pen on the correct Y-Axis voltage. Ex: 130 W = 0.848 VDC, 130 W + 130 W offset = 260 Watt calibration point.

r) After calibrating upper end of both X and Y-Axis return the SUPPERSSION POTS to zero.

s) Turn SERVO SWITCH OFF.

t) Set the VOLT/WATT SWITCH to VOLT and apply a suppression voltage (-VDC) by adjusting the VOLT SUPPRESSION POT. Ex: 20 V = -0.659 VDC.

u) Set the VOLT/WATT SWITCH to WATT and apply a suppression voltage (-VDC) by adjusting the WATT SUPPRESSION POT Ex: 130 W = -0.848 VDC.

v) Repeat steps 3) thru 6) after turning OVEN breaker ON.

w) Turn SERVO SWITCH ON and PEN SWITCH into PEN-DOWN position, when voltage on Fluke 8050A goes positive.

x) Gradually increase TEMPERATURE VARIAC whenever recorder pens slows down. Start at 30 percent and then increase to 90 percent.

y) Turn SERVO SWITCH OFF and turn PEN SWITCH into PEN-UP position, when the pen leaves the right side of the trapezoid.

z) Turn POWER VARIAC and the TEMPERATURE VARIAC OFF. Let test lamp cool down.

Repeat steps u thru z for the +/- 10 percent rated line voltage curves. Use different ink colors for distinctive curves.

### c) Power Factor Curve

1) The setup for the Power Factor Characteristic Curves is as follows:

a) POWER VARIAC in OFF position.

b) Set VOLT/WATT SWITCH to VOLT.

c) Adjust VOLT SUPPESSION POT until Fluke 8050A reads zero.

d) Set VOLT/WATT-POWER FACTOR SWITCH to WATT-POWER FACTOR.

e) Adjust the POWER FACTOR SUPPRESSION POT until Fluke 8050A reads zero.

f) Turn SERVO SWITCH ON.

g) Adjust the recorder X-Axis ZERO POT to read 20 on the X-Axis of the recorder.

h) Adjust the recorder Y-Axis ZERO POT to set the pen in the center of Y-Axis.

i) A power factor scale is entered on the right side of the graph, with the zero line in the center of the Y-Axis. The scale is from +1.0 to -1.0 with major divisions of 0.2 (See Figure 6).

j) Adjust the POWER FACTOR SPPRESSION POT to read ±1 V on theFluke 8050A.

k) Adjust Y-Axis VERNIER to calibrate recorder pen at±1 Volt at same time.

l) Turn SERVO SWITCH OFF.

m) Set the VOLT/WATT SWITCH to VOLT and apply a suppression voltage (-VDC) by adjusting the VOLT SUPPRESSION POT.

Ex: 20 Volt = -0.659 VDC

n) Press YEW POWER FACTOR button marked W/VA.

o) Switch WATTS/POWER FACTOR SWITCH to POWER FACTOR position.

p) Repeat steps 3) thru 5) from Lamp Stabilization Procedure.

q) Turn SERVO SWITCH ON and PENSWITCH into PEN-DOWN position, when voltage on Fluke 8050A goes positive.

r) Gradually increase TEMPERATURE VARIAC whenever recorder pen slows down.

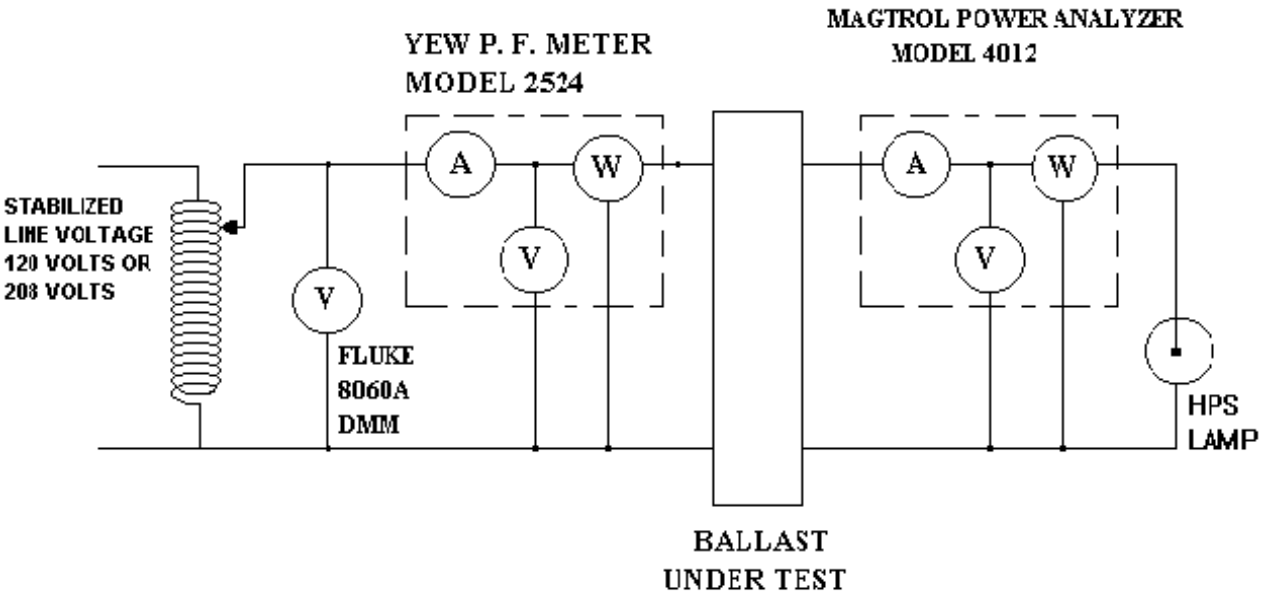
s) Turn SERVO SWITCH OFF and turn PEN SWITCH to PEN-UP position, when the pen leaves the right side of the trapezoid.

t) Turn POWER VARIAC and TEMPERATURE VARIAC OFF. Let test lamp cool down before handling.

## D. SAFETY AND HEALTH

Prior to handling, testing or disposing of any materials, testers are required to read Caltrans Laboratory Safety Manual-Part A, Section 5.0, Hazards and Employee Exposure; Part B, Sections: 5.0, Safe Laboratory Practices; 6.0, Chemical Procurement Distribution and Storage; and 10.0, Personal Protective Apparel and Equipment; and Part C, Section 1.0; Safe LaboratoryPractices.

**End of Test (California Test 608 contains 11 pages)**




**SIMPLIFIED BALLAST TEST SET-UP**

**FIGURE 1.**

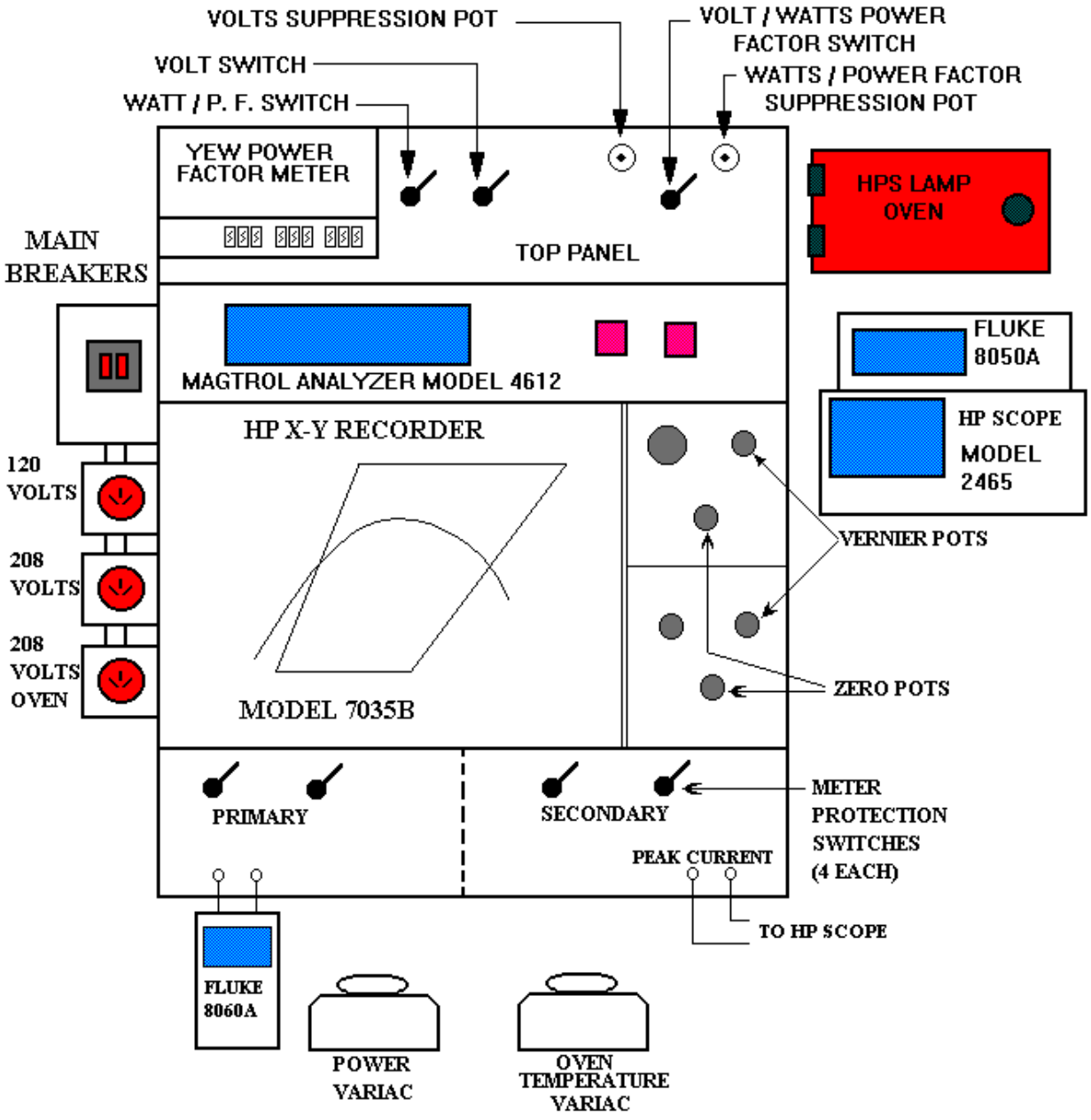
## H. P. S. BALLAST TESTING

**BALLAST:** **SM. NO.:**

**LAMP:** **MFG.:**
**CAT. NO.:** **LOT NO.:**
**CAPACITOR:** **DATE:**

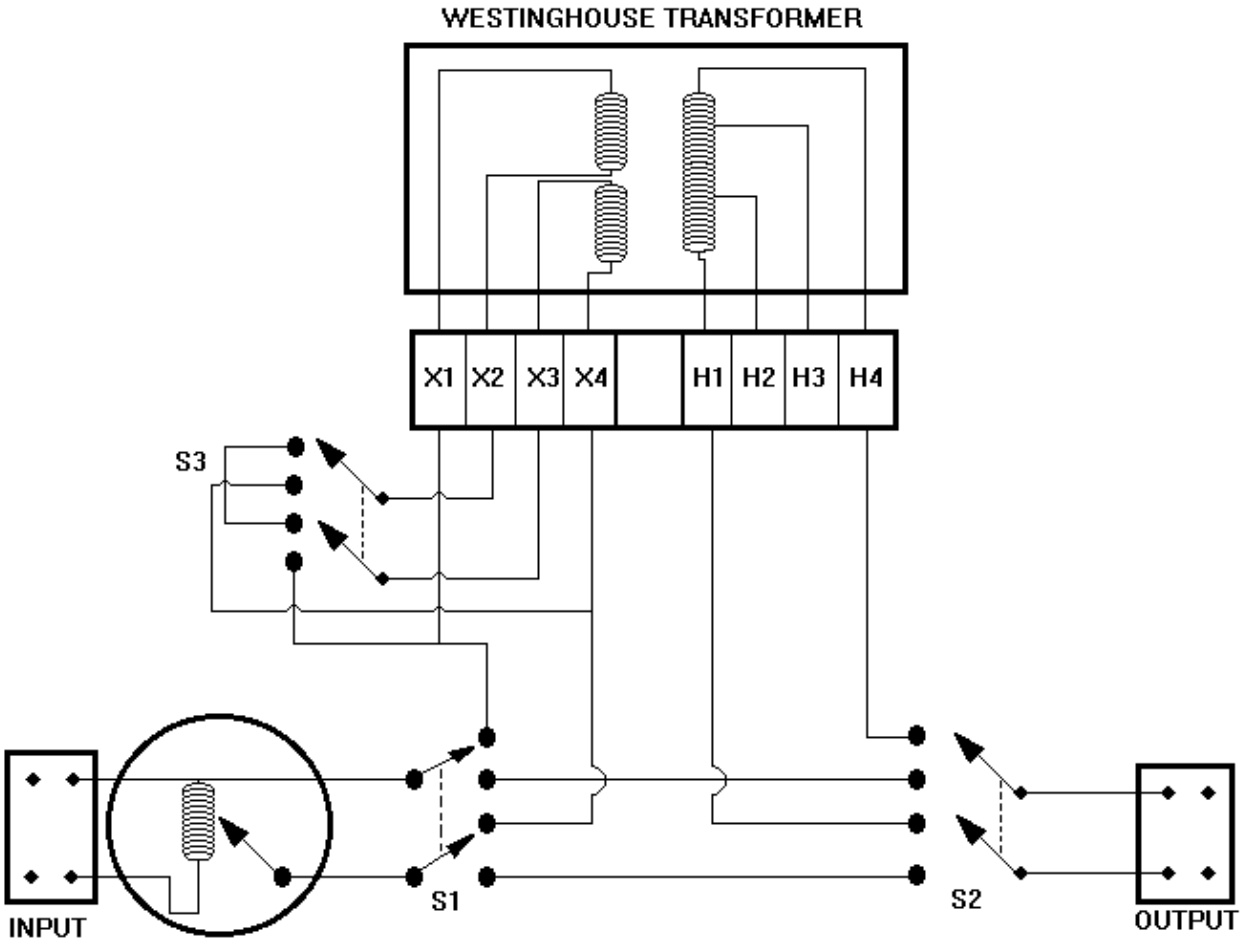
| INPUT | | | | OUTPUT | | | | |
|---|---|---|---|---|---|---|---|---|
| INPUT VOLTS | INPUT CURRENT | INPUT WATTS | POWER FACTOR | LAMP VOLTS (Vo) | PEAK CURRENT (Ip) | RMS CURRENT (Irms) | OUTPUT WATTS (Wo) | CREST FACTOR Ip/Irms |
| | | | | | | | | |

**FORMS FOR RECORDING PARAMETERS AT LAMP STABILIZATION**
**FIGURE 2.**




**Test Equipment Layout for Ballast Testing**

**Figure 3.**

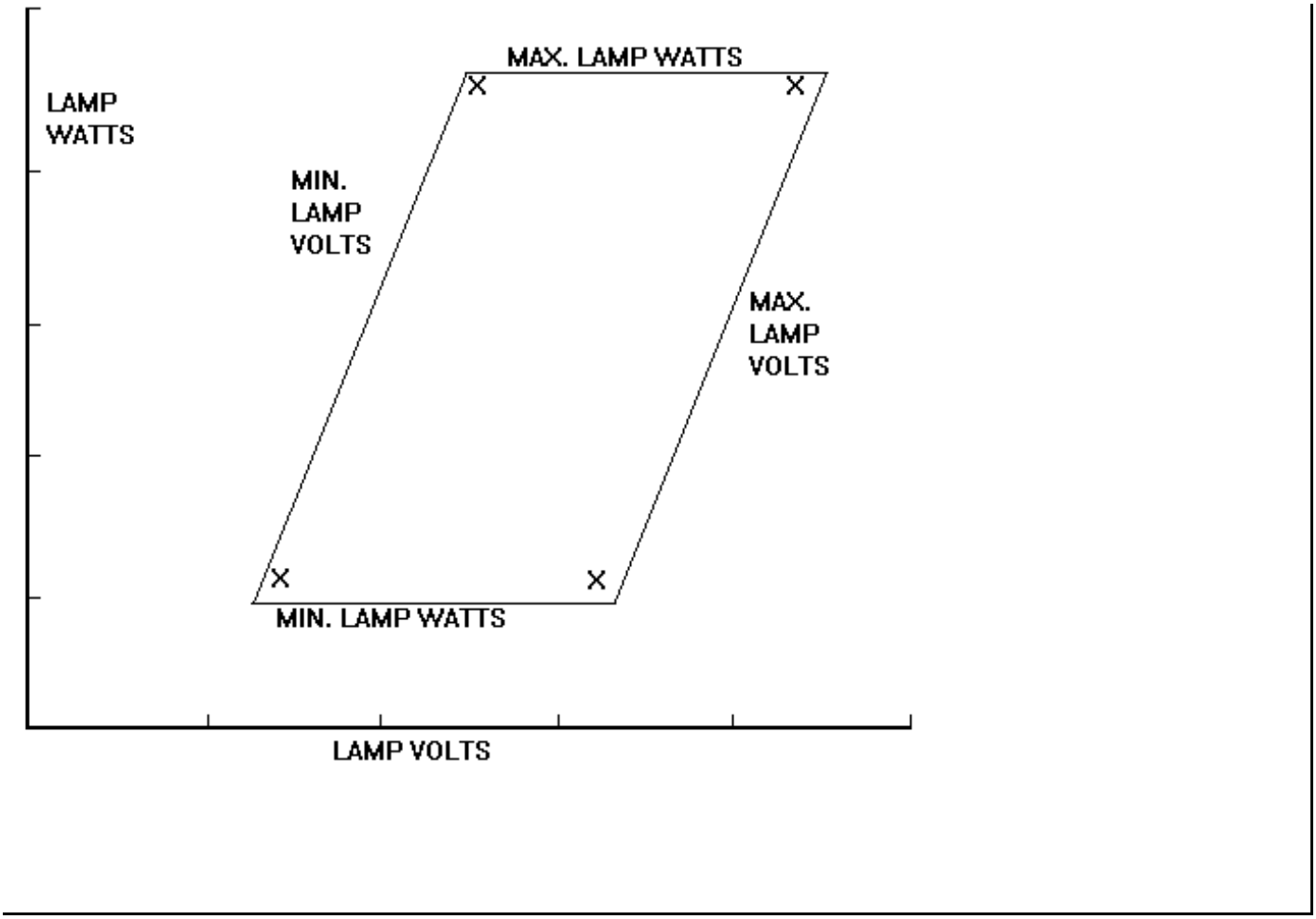



**120 / 208 ⟶ 120 / 240 / 480**

**1) To bypass transformer:** **set "S1" & "S2" to 120 volts**

**2) To use transformer:** **set "S1" to primary**
**set "S2" to secondary**
**set "S3" to proper input**

**Input Power Control Board**
**Figure 4.**

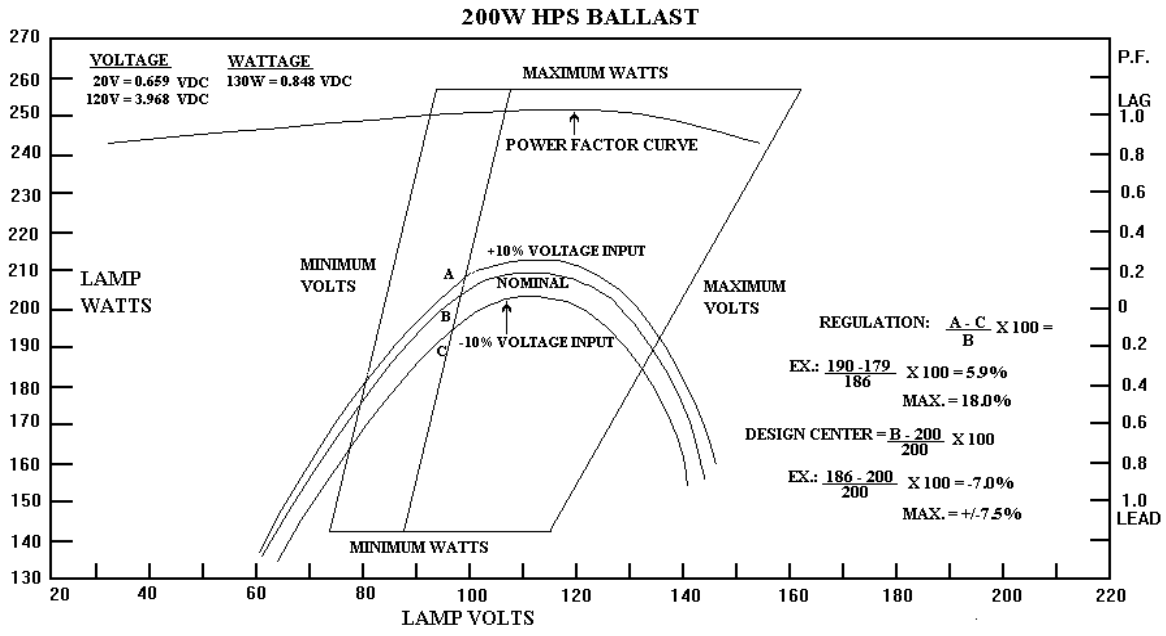



## Trapezoid Limits for the various wattages

| Rated Lamp Watts | 50 | 70 | 100 | 150 | 200 | 250 | 310 | 400 | 1000 |
|---|---|---|---|---|---|---|---|---|---|
| Min. Watts | 38 | 50 | 72 | 110 | 140 | 175 | 210 | 280 | 750 |
| Max. Watts | 65 | 90 | 124 | 180 | 260 | 350 | 390 | 490 | 1200 |
| Min. Volts | 46 | 44 | 45 | 48 | 90 | 85 | 90 | 84 | 210 |
| Max. Volts | 84 | 84 | 84 | 85 | 160 | 160 | 160 | 152 | 350 |
| Lamp Voltage Limits to establish the corners of trapezoid (At X Points) | | | | | | | | | |
| for Corners of Trapezoid | | | | | | | | | |
| At Max. Watts | 55/99 | 50/104 | 51/96 | 54/97 | 105/200 | 109/194 | 105/186 | 97/172 | 235/390 |
| At Min. Watts | 39/72 | 38/64 | 38/71 | 40/69 | 75/120 | 67/134 | 71/128 | 67/125 | 175/300 |

## Trapezoid Limits as defined by ANSI

**Figure 5.**




**LAMP WATTAGE TRAPEZOID**

**FIGURE 6.**

## MAGTROL SETTINGS 5A-150V

| VOLTAGE | WATTAGE |
|---|---|
| 10 V = 0.305 Vdc | 40 W = 0.268 Vdc |
| 20 V = 0.609 Vdc | 50 W = 0.336 Vdc |
| 30 V = 0.917 Vdc | 60 W = 0.405 Vdc |
| 40 V = 1.218 Vdc | 70 W = 0.470 Vdc |
| 50 V = 1.523 Vdc | 80 W = 0.542 Vdc |
| 60 V = 1.828 Vdc | 90 W = 0.610 Vdc |
| 70 V = 2.132 Vdc | 100 W = 0.680 Vdc |
| 80 V = 2.436 Vdc | 110 W = 0.747 Vdc |
| 90 V = 2.737 Vdc | 120 W = 0.815 Vdc |
| 100 V = 3.043 Vdc | 130 W = 0.883 Vdc |
| 110 V = 3.345 Vdc | 140 W = 0.948 Vdc |
| 120 V = 3.643 Vdc | 150 W = 1.018 Vdc |
| 130 V = 3.948 Vdc | 160 W = 1.084 Vdc |
| | 170 W = 1.152 Vdc |
| | 180 W = 1.223 Vdc |
| | 190 W = 1.290 Vdc |
| | 200 W = 1.357 Vdc |

## MAGTROL SETTINGS 2A-150V

| | |
|---|---|
| 20 V = 0.610 Vdc | 30 W = 0.516 Vdc |
| 90 V = 2.740 Vdc | 40 W = 0.687 Vdc |

## MAGTROL SETTINGS 10A-150V

| | |
|---|---|
| 20 V = 0.609 Vdc | 220 W = 0.751 Vdc |
| 120 V = 3.650 Vdc | |

## MAGTROL SETTINGS 10A-300V

| | |
|---|---|
| 60 V = 0.915 Vdc | 600W = 1.027 Vdc |
| 100 V = 1.527 Vdc | |
| 120 V = 1.831 Vdc | |

FIGURE 7. VOLTAGE/WATTAGE CURVE CALIBRATION SETTINGS